One-way waveguides in photonic crystals based on an analogy of quantum Hall edge states

Hiroyuki Takeda and Sajeev John,
Department of Physics, University of Toronto, 60 St. George ST., Toronto Ontario Canada, M5S 1A7

In conventional photonic-crystal waveguides, the light can propagate in both directions. However, it has been proposed that one-way waveguides, in which the light can propagate only in a certain direction, can be obtained in two-dimensional triangular-lattice photonic crystals, based on an analogy of quantum Hall edge states in electronic physics [1,2].

We explore more realistic structures to obtain one-way waveguides, and demonstrate the one-way waveguides in two-dimensional square-lattice photonic crystals with magneto-optical materials. By inducing interfaces in these photonic crystals, there appear the one-way waveguides. Magneto-optical materials and interfaces break time reversal and space inversion symmetry, respectively. Both time reversal and space inversion symmetry breakdowns enable nonreciprocal light propagation in photonic crystals. A mechanism of the one-way waveguides can be explained by considering Berry curvatures.

[1] F. D. M. Haldane and S. Raghu, cond-mat/0503588.
[2] S. Raghu and F. D. M. Haldane, cond-mat/0602501.